MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
«IGOR SYKORSKY KYIV POLYTECHNIC INSTITUTE»

APPROVED BY
Deputy Director
for scientific and pedagogical work
IPT Igor Sikorsky Kyiv Polytechnic Institute
Lytvynova T.
30.05.2018

Physics 1. Mechanics

Work Program

for students preparing the first (Bachelor) level of higher education
«Bachelor» of the specialties 113 Applied Mathematics
125 Cybersecurity

Approved by methodical commission
IPT Igor Sikorsky Kyiv Polytechnic Institute
Protocol № 6/2018 of May 24, 2018 p.
Head of methodical commission
Smirnov S.
24.05.2018

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The work program of the credit module «Physics 1. Mechanics» for students preparing the first (Bachelor) level of higher education «Bachelor» in the speciality 125 Cybersecurity, 113 Applied mathematics, according to the full-time form of study is compiled accordingly to the program of the subject «Physics»

Developer of program of the subject:

associate professor, candidate of physical and mathematical sciences

Ponomarenko Sergiy Mykolajovysh

The program is approved at the sessions of the information security department Protocol № 5/2018 of April 25, 2018

Acting head of department

associate professor Graivoronsky M. V.

25.04.2018

The program is approved at the sessions of the mathematical methods of information security department Protocol № 4/2018 of April 17, 2018

Head of department

full professor Savchuk M. M.

17.04.2018

Introduction

This program covers the first section of the course in general physics — mechanics and mechanical oscillations. After listening of this course, students can obtain systematic knowledge of the basic concepts and definitions of mechanics, the basic principles of describing mechanical phenomena, get acquainted with the basics of the experiment.

To master the course material, students must be able to solve algebraic equations and simple differential equations, differentiate, integrate, and know elements of vector algebra.

1. Description of the credit module

Branch of knowledge, direction of training, educational and qualification level	**General Indicators**	**Characteristics of the credit module**
Branch of knowledge 12 «Information technologies»	Discipline Physics 1. Mechanics	Form of study full-time
Training direction 125 «Cyber Security»	Number of ECTS credits 5.0	The status of the credit module normative
Speciallity 125 «Cyber Security»	Number of chapters	Cycle fundamental natural science training
Speciallization	Individual problems _____ (kind)	Year 2018 Semester 1
Academic degree bachelor	Total hours 150	Lectures 36 hrs., Practical work 36 hrs., Lab classes 18 hrs.
	Weekly hours: classrooms — 5 individual — 3	Individual work 60 Type and form of semester control exam

2. Purpose and tasks of the credit module

The purpose of the credit module is to form students with knowledge and abilities of:

- laws of mechanics and their application for the interpretation and description of observed phenomena,
- methods and techniques for describing motion of bodies,
- principles of measurement of physical quantities and processing of experimental data.

As a result of the course's study, students develop the ability to interpret the phenomena of nature, to solve problems on the basis of fundamental knowledge of the laws of mechanics.

3. Structure of the credit module

Content of modules and themes	Number of hours				
	Total	including			
		Lectures	Practical work	Laboratory classes	Independent work
1	2	3	4	5	6
Module 1. Mechanics					
1.1. Kinematics	15	6	6		3
1.2. Dynamics. Equation of motion	18	4	4	4	6
1.3. Non-inertial frame of reference	6	2	2		2
1.4. Work and energy	16	4	4	4	4
1.5 Angular Momentum Conservation Law	8	4	2		2
1.6. Classical central-force problem	7	2	4		1
1.7. Rigid body dynamics	10	2	2	4	2
Control work 1	2				2
1.8. The principle of relativity. Dynamics or Special Relativity Theory.	12	4	4		4
Calculation work	16		2		14
Module 2. Mechanical oscillations					
2.1. Oscillatory motion and its characteristics. Equation of oscillation. Harmonious oscillation. Graphic representation of harmonic oscillation by the method of vector diagrams. Superposition of unidirection oscillations, perpendicular oscillations, beats	12	4	2	4	2

Content of modules and themes	Number of hours				
	Total	including			
		Lectures	Practical work	Laboratory classes	Independent work
1	2	3	4	5	6
2.2. Representation of oscillations in a complex form. Differential equations of forced oscillations of an elastic pendulum, a mathematical and physical pendulum. Types of oscillations and their differential equations	8	2	2		4
Control work 2	4		2		2
Laboratory quiz	4			2	2
Module control work	6	2			4
Differential quiz	6				6
Total	150	36	36	18	60

4. Lectures

Seq. №	Lecture theme and list of main questions (also a list of didactic support, references and assignments for the individual work)
1.	**Kinematics of the particle**. Space and time. Reference frame. Material point. Radius vector. Trajectory, path, movement. Average and instantaneous velocity. Vector, coordinate methods for describing motion. Presentation of lecture 1, **IrodovMechanics**, § 1.1, **BerkeleyMechanics**, Chapter 2, **Holyday**, Chapter 2, Chapter 3, Chapter 4.
2.	Parametric description of the movement. Rotational motion of a point and its angular characteristics Presentation of lecture 2, **IrodovMechanics**, § 1.1, 1.2, **BerkeleyMechanics**, Chapter 2.
3.	**Kinematics of a rigid body**. Progressive, rotational, flat motion of a solid body. Motion around a fixed point. Euler's theorem Presentation of lecture 3, **IrodovMechanics**, § 1.2, **BerkeleyMechanics**, Chapter 2, **Holyday**, Sections 10-1, 10–2, 10–3, 11–1.
4.	**Dynamics**. The concept of force. Types of interactions in modern physics. Types of forces. Newtonian laws. Equation of particle motion, many-particle system. Momentum Conservation Law. Presentation of lecture 4, **IrodovMechanics**, Chapter 2 (except § 2.5), **BerkeleyMechanics**, Chapter 3, **Holyday**, Sections 1-3, Chapter 5, Chapter 6.
5.	**Center of mass**. Theorem on the motion of the center of mass. Reference frame of the center of mass. **Equation of motion of a body with a variable mass** Presentation of lecture 5, **IrodovMechanics**, Chapter 4, **BerkeleyMechanics**, Conservation of momentum, **Holyday**, Chapter 9.

Seq. №	Lecture theme and list of main questions (also a list of didactic support, references and assignments for the individual work)
6.	**Non-inertial reference frame.** Inertial forces. Presentation of lecture 6, **IrodovMechanics**, § 2.5, **BerkeleyMechanics**, Chapter 4, ADVANCED TOPICS.
7.	**Work and energy**. Work of force. Power of force. Potential, conservative forces. Work of conservative forces. Potential energy and its normalization. Relationship between conservative force and potential energy. Gradient. Presentation of lecture 7, **IrodovMechanics**, § 3.1 – 3.4, **BerkeleyMechanics**, Chapter 5, **Holyday**, Chapter 7, Chapter 8.
8.	Relationship between work of force and the change of the kinetic energy of a point. Kinetic energy of many-particle system. Total mechanical energy conservation law. The work of dissipative forces. Presentation of lecture 8, **IrodovMechanics**, § 3.5.
9.	**Angular Momentum Conservation Law.** Angular momentum, torque (moment of force). Rate of change of angular momentum for particle and many-particle systems. Angular momentum conservation. Presentation of lecture 9, **IrodovMechanics**, § 5.1 – 5.3, **BerkeleyMechanics**, Chapter 6, **Holyday**, Sections 10-4 – 10-8, 11-7(The Angular Momentum of a System of Particles).
10.	**Classical central-force problem**. Central forces. Potential energy in central force field. Conservation Laws in central force field. Kepler's laws of planetary motion. Presentation of lecture 10, **BerkeleyMechanics**, Chapter 9, **Holyday**, Chapter 13.
11.	**Rigid body dynamics**. The equation of motion of Rigid body. Relation between angular momentum and angular velocity. Rotation of the body relative to the fixed axis. Kinetic energy of rotating body. Presentation of lecture 11, **IrodovMechanics**, § 5.4, **BerkeleyMechanics**, Chapter 8, **Holyday**, Chapter 11.

Seq. №	Lecture theme and list of main questions (also a list of didactic support, references and assignments for the individual work)
12.	The moment of inertia of a particle, many-particle system and rigid body. Parallel axis theorem (Huygens–Steiner theorem). Presentation of lecture 12, **BerkeleyMechanics**, Chapter 8 (MOMENTS OF INERTIA, Parallel Axis Theorem).
13.	**The principle of relativity.** Properties of space and time. Inertial reference systems. Galilean transformation and their effects. Postulates of the special theory of relativity. Properties of light speed in vacuum. Presentation of lecture 13, **IrodovMechanics**, § 6.1, 6.2, 6.3, **BerkeleyMechanics**, Chapter 10.
14.	Lorentz transformations. The interval between events. World line Light Cone of Events. Types of intervals. Consequences of the Lorentz transformations — time dilation, relativity of simultaneity, the length contraction, velocity-addition formula. Presentation of lecture 14, **IrodovMechanics**, § 6.4, 6.5, 6.6, **BerkeleyMechanics**, Chapter 11.
15.	**Dynamics or Special Relativity Theory**. Conservation of momentum and definition of relativistic momentum. Relativistic energy. Transformation of momentum and energy. Relativistic equation of motion. Presentation of lecture 15, **IrodovMechanics**, Chapter 7, **BerkeleyMechanics**, Chapter 12.
16.	**Mechanical oscillations**. scillatory motion and its characteristics. Equation of oscillation. Harmonious oscillation. Graphic representation of harmonic oscillation by the method of vector diagrams. Adding of one direction oscillations, perpendicular oscillations, beats. Presentation of lecture 16, **BerkeleyWaves**, Chapter 1, **Holyday**, Sections 15-1 – 15-3.

Seq. №	Lecture theme and list of main questions (also a list of didactic support, references and assignments for the individual work)
17.	Representation of oscillations in a complex form. Differential equations of forced oscillations of an elastic pendulum, a mathematical and physical pendulum. Types of oscillations and their differential equations. Presentation of lecture 17, **BerkeleyMechanics**, Chapter 3, **Holyday**, Sections 15-4, 15–5, 15–6.
18.	**Module control work**.

5. Practical work

Seq. №	Theme and list of main questions (also a list of didactic support, references and assignments for the individual work)
1.	Vector, coordinate methods for describing motion. **IrodovProblems**, § 1.1
2.	Parametric description of the movement. Rotational motion of a point and its angular characteristics. **IrodovProblems**, § 1.1
3.	Kinematics of a rigid body. Progressive, rotational, flat motion of a solid body. Motion around a fixed point. **IrodovProblems**, § 1.1
4.	Dynamics. Newtonian laws. **IrodovProblems**, § 1.2
5.	Equation of motion of a body with a variable mass. **IrodovProblems**, § 1.3
6.	Non-inertial reference frame. Inertial forces. **IrodovProblems**, § 1.2
7.	Work and energy. **IrodovProblems**, § 1.3

Seq. №	Theme and list of main questions (also a list of didactic support, references and assignments for the individual work)
8.	Conservation Laws. **IrodovProblems**, § 1.3
9.	Classical central-force problem. **IrodovProblems**, § 1.4
10.	Angular Momentum Conservation Law. **IrodovProblems**, § 1.3
11.	Rigid body dynamics. **IrodovProblems**, § 1.5
12.	Control work 1
13.	Calculation work
14.	Kinematics of special relativity. **IrodovProblems**, § 1.8
15.	Dynamics of special relativity. **IrodovProblems**, § 1.8
16.	Oscillations. **IrodovProblems**, § 4.1
17.	Adding of oscillations. **IrodovProblems**, § 4.1
18.	Control work 2

6. Laboratory classes

Seq. №	Laboratory works	Hours
1.	Studying the motion of bodies in the field of gravity using the Atwood's machine. http://www.gtu.edu.tr/Files/UserFiles/90/M8-ENG.pdf	4
2.	Study of the laws of rotational motion on the example of the Oberbeck's pendulum. http://elartu.tntu.edu.ua/bitstream/123456789/82/3/experiment3.pdf	4
3.	Study of Conservation Laws of momentum and total mechanical energy on an example of collisions.	4
4.	Study of the motion of the physical pendulum.	4

7. Independent work

Seq. №	Title of section, topic (separate issue) to be made on independent study	Hours
1.	Gyroscope **Holyday**, Sections 11-9.	2
2.	Velocity-addition formula in special relativity theory **BerkeleyMechanics**, Chapter 11, Velocity Transformation.	2
3.	Adding oscillations. Vector diagrams. Lissage figures. Beats https://en.wikipedia.org/wiki/Beat_(acoustics), **FLF1**, Chapter 48, http://www.feynmanlectures.caltech.edu/I_48.html	2

8. Individual work

Calculation and graphics work is a kind of independent work of students. It is executed as a semester problem and contains an individual set of problems of a calculated and graphical character, which covers the material of the semester. Problem options for calculation work are given by the teacher at beginning of the semester.

9. Control works

Two intermediate control works, one modular control work.

10. Bybliography

Main

BerkeleyMechanics Ch. Kittel et al. Mechanics (Berkeley Physics Course, Vol. 1). McGraw-Hill Book Company, 1973.

BerkeleyWaves F. S. Crawford. Waves, (Berkeley Physics Course, Vol. 3). McGraw-Hill Book Company, 1968.

Holyday D. Halliday, R. Resnik, and J. Walker. Fundamentals of Physics. 10th ed. 1450 pp.

IrodovMechanics I. E. Irodov. Fundamental Laws of Mechanics. CBS publishers & distributors, 2004.

IrodovProblems I. E. Irodov. Problems in general physics. Revised. Mir Publishers, 1988.

Additional

BerkeleyMechanics Ch. Kittel et al. Mechanics (Berkeley Physics Course, Vol. 1). McGraw-Hill Book Company, 1973.

Crowell1 B. Crowell. Mechanics. Light and Matter. eprint: `http://www.lightandmatter.com/mechanics/`.

FLF1 R. Feynman, R. Lejton, and M. Sends. Lectures on physics. Vol. 1. Mainly mechanics, radiation, and heat. New Millenium Edition. Basic Books, 2010. 968 pp.